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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/726,059	11/29/2000	Alan D. Kersey	WEAF---/LWT	8667

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EXAMINER	
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ART UNIT	**PAPER NUMBER**
2882	

DATE MAILED: 04/23/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/726,059	Applicant(s) KERSEY ET AL.	
	Examin r Krystyna Suchecki	Art Unit 2882	

-- Th MAILING DATE of this communication appears on the cover she t with the correspond nce address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-72 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-72 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☒ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Specification

1. Examiner requests Applicant's assistance in determining and editing the status of applications referenced in the specification on pages 6 and 9, and any others of which Applicant becomes aware.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

3. Claims 52 and 71 are rejected under 35 U.S.C. 112 for the following reason: it is not clear from the claims or specification how an acoustic disturbance in a fluid could travel at the speed of the fluid, since the fluid flow to enable this occurrence is on the order of several hundred miles per hour. How or why fluid would travel at such a speed is not readily ascertained from the claims or specification.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims **1-72** are rejected under 35 U.S.C. 103(a) as being unpatentable over Kersey (US 5,987,197, referenced herein as '197) in view of Kersey (US 5,361,130, referenced herein as '130), '197 and Applicant's admission of prior art (referenced herein as AAA). **Please note that claim numbers are marked in bold to assist with clarity.**

6. Regarding Claims **1-12** and **32-52,** Figures 1 and 2 of Kersey '197 teaches a method of interrogating at least one fiber optic sensor comprising:

Claims 1, 32 and 37: Generating successive light pulses;

Combining first and second light pulses onto a single optical fiber;

Directing the pulses through a first periodic grating of low reflectivity, through an optical sensor and through a second periodic grating of low reflectivity;

Receiving reflected pulses from the gratings by combining reflected pulses;

Splitting the light pulses into first and second light pulses;

Delaying the second light pulses a known time period relative the first pulses;

Imparting an additional phase shift to the pulses with an interferometer; and

Determining a phase shift between the coincident reflected light pulses;

Claim 2: Comparing the phase shift from the successive pulses (Figure 2);

Determining a change in magnitude of the measured parameter from the comparison of the successive phase shifts (Background, paragraph 2)

Claim 4: Directing light pulses through an optical splitter (Figure 1);

Claim 5: Directing reflected pulses through an optical splitter before further processing (Figure 1);

Claims 6, 35 and 36: Directing pulsed light through a time delay device;

Claims 7 and 42: Imparting a time period delay equal to about the same time as the double-pass time of a light pulse through the sensor (Column 1);

7. '197 does not teach **(Claims 1 and 32)** the use of the sensor couple to a pipe and sensing parameters of fluid in the pipe; **(Claims 1, 32, 35, 38)** splitting the light pulses into first and

second light pulses, delaying one pulse in relation to the other and then directing the split pulses through a fiber optic sensor in order to create first and second reflected signals for the first pulse and first and second reflected signals for the second pulse and then determining a phase shift between the reflected first light pulse and second grating and the reflected second light pulse and first grating; **(Claims 3, 34)** impressing a modulation carrier onto the first light pulses; **(Claims 5, 39)** explicit use of an optical receiver after an optical splitter to receive reflected light pulses; **(Claims 8, 43)** generation of light pulses using a continuous output distributed feedback laser and an integrated optics chip (i.e., a gateable distributed feedback laser); **(Claim 9)** generation of light pulses of about 1 usec in duration; **(Claim 10)** using a known time period of about 1 usec; **(Claim 11)** first and second gratings tailored to reflect light having a wavelength of about 1545 nm; **(Claim 12)** successive pulses generated at about 16 usec intervals; **(Claims 33, 52)** the sensor comprising at least one wrap of fiber optic cable, **(Claim 40)** coupling an optical pathway to a photo receiver by an optical circulator; **(Claim 41)** the photo receiver coupled to instrumentation to determine the phase shift; **(Claim 44)** the light pulse having a duration approximately equal to the time period; **(Claims 45-49)** a serially-connected plurality of sensors each bound by a pair of first and second reflectors, wherein each sensor comprises its own unique pair of first and second reflectors, wherein each pair of reflectors reflects light of a wavelength different from other pairs of reflectors, wherein each pair of first and second reflectors is not unique to a sensor such that the first reflector of a first sensor comprises the second reflector of a second sensor adjacent the first sensor and wherein each of the pairs of reflectors reflect light of a common wavelength; **(Claims 50-51)** sensors detecting acoustic

disturbances in the fluid that travel at the speed of sound in the fluid, or disturbances that travel at the speed of the fluid.

8. '197 does further teach the improvement to the prior art arrangement of Figure 1 to include the arrangement of Figure 4, which comprises a serially-connected plurality of sensors each bound by a pair of first and second reflectors, wherein each sensor comprises its own unique pair of first and second reflectors, wherein each pair of reflectors reflects light of a wavelength different from other pairs of reflectors, wherein each pair of first and second reflectors is not unique to a sensor such that the first reflector of a first sensor comprises the second reflector of a second sensor adjacent the first sensor and wherein each of the pairs of reflectors reflect light of a common wavelength in order to decrease cross-talk between sensor pairs in an array of sensors.

9. Kersey '130 teaches a pulsed sensor system and an interferometric device with a path length difference positioned after a light source and before a sensor system as interchangeable with, and therefor teaches this as equivalent to, a system wherein an interferometer is used after light is passes through a sensor system (Column 8). The interferometer is used in order to enhance the phase stability of the system and therefor the resolution with respect to changes in the measurand field (Column7). The interferometer of '130 impresses a modulation carrier onto the light in the path opposite the delayed path in order to provide a high signal to noise ratio and wide dynamic range (Column 5, lines 41-55). '130 also uses an optical receiver (item 180) after an optical splitter (item 205) in order to electronically process the interferometric signal created. Also taught is the importance of selecting the appropriate duration of a light pulse, time period, grating wavelength and pulse interval (Column 3, 9 and others). Kersey '130 teaches that a

routineer in the art should know how to select the above items, since the values determine whether or not the system will work. '130 also teaches the use of his system in a plurality of environments, including pressure and acoustical systems (Column 2, lines 42-49).

10. Applicant (AAA) also admits that it is known in the art to use a sensor coupled to a pipe to sense parameters within the pipe (page 10).

11. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to utilize the features and teachings of '130 and AAA in '197 in order to have several benefits. A first benefit would be to use a known expedient to enhance the phase stability of the system and therefor the resolution with respect to changes in the measurand field by placing an interferometer with a path length difference before a sensor ('130, Column7). The system would benefit by splitting the light pulses into first and second light pulses, delaying one pulse in relation to the other and then directing the split pulses through a fiber optic sensor in order to create first and second reflected signals for the first pulse and first and second reflected signals for the second pulse and then determining a phase shift between the reflected first light pulse and second grating and the reflected second light pulse and first grating. A second benefit would be to have a high signal to noise ratio and wide dynamic range by impressing a modulation carrier on the signal ('130, Column 5, lines 41-55). A third benefit would be to process the interferometric signal created by using a photo receiver and instrumentation to detect phase changes in the signal and therefor detecting pressure and acoustical signals. Official notice is taken that the use of optical circulators and integrated optics and distributed feedback lasers are well known in the art. See In re Malcolm, 1942 C.D. 589; 543 O.G. 440, and the prior office action teaching these expedients. Kersey '197 teaches it would obvious to one of ordinary skill in

the art at the time the invention was made to arrange the reflectors within a sensor system serially and spaced as outlined above for the purpose of reducing cross-talk between sensor pairs in an array of sensors. Applicant admits that it is obvious to couple fiber optic sensor systems to pipes to sense disturbances in the pipe by wrapping the sensor around the pipe. It would be further obvious, in light of '130, to use a sensor system as outlined above to sense pressure and acoustical disturbances and to extrapolate relevant information about those disturbances regardless of the speed of the disturbances, since the sensor systems are designed to achieve that goal. Also, it has been held that a recitation with respect to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus/method from a prior art apparatus/method satisfying the claimed structural limitations. Ex parte Masham, 2 USPQ2d 1647 (1987).

12. Regarding Claims **13-31** and **53-72**, '197 teaches in figures 1 and 2 and Column 1 an apparatus for interrogating at least one interferometric fiber optic sensor, the sensor optically connected between a pair of reflective gratings comprising:

Claims 13, 53, 56 and 59: A light source;

A first optical coupler optically connected to the light source;

A directional coupler optically connected to the light source;

An optical transmission cable optically connected to the directional coupler and optically connected to the at least one interferometric fiber optic sensor;

An interferometric device with two paths and a time delay device in one of the paths bound by two couplers, both directional, optically connected to the sensor

Claims 16, 53 and 56: A time delay having an optical length and a sensor having a nominal optical length and wherein the optical length of the time delay is substantially the same as twice the nominal optical length of the sensor;

Claim 17: Pulsing of the optical signal (Figure 1)

Claims 18 and 53: Reflective gratings reflecting the same wavelength;

Claim 19: Bragg gratings for the reflective gratings;

Claim 30: The optical length of the time delay as substantially equal to a nominal optical length of the sensor

Claim 60: An interference signal of the phase of the light signal dependent upon phase shift perturbations between two fiber Bragg grating reflectors;

Claim 61: The sensor having a double-pass optical time-of-flight between the first and second reflectors, and wherein the time delay is approximately equal to the double-pass time-of-flight.

13. ‘197 does not teach the use of the sensor couple to a pipe and sensing **(Claim 13)** parameters of fluid in the pipe or for sensing **(Claim 53)** acoustic disturbances; **(Claims 13, 53)** splitting the light pulses into first and second light pulses, delaying one pulse in relation to the other and then directing the split pulses through a fiber optic sensor in order to create first and second reflected signals for the first pulse and first and second reflected signals for the second pulse and then determining a phase shift between the reflected first light pulse and second grating and the reflected second light pulse and first grating; **(Claims 13, 53)** explicit use of an optical receiver after an optical splitter to receive reflected light pulses; **(Claims 14, 55)** impressing a modulation carrier onto the first light pulses; **(Claims 15, 64)** an optical amplifier optically connected to the apparatus; **(Claims 20-25)** sensors in a sensing system arranged to

capture desired acoustic or pressure variation signal information by spacing the sensors a known or determinable distance apart, understood to include equidistantly; **(Claims 26, 58)** an optical circulator for a directional coupler, the circulator coupled to a **(Claim 58)** photo receiver; **(Claim 27)** generation of light pulses using a continuous output distributed feedback laser and an integrated optics chip (i.e. a **(Claim 62)** gateable distributed feedback laser); **(Claim 28)** generation of light pulses of about 1 usec in duration; **(Claim 29)** first and second gratings tailored to reflect light having a wavelength of about 1545 nm; **(Claim 31)** successive pulses generated at about 16 usec intervals; **(Claims 54, 72)** wherein the sensor comprises at least one wrap of fiber optic cable; **(Claim 57)** the optical delay device comprising a delay coil; **(Claim 60)** a photo receiver coupled to instrumentation to determine a phase shift in pulses from the sensor; **(Claim 63)** a light source emitting at least one pulse with a duration equal to the time delay; **(Claims 65-69)** a serially-connected plurality of sensors each bound by a pair of first and second reflectors, wherein each sensor comprises its own unique pair of first and second reflectors, wherein each pair of reflectors reflects light of a wavelength different from other pairs of reflectors, wherein each pair of first and second reflectors is not unique to a sensor such that the first reflector of a first sensor comprises the second reflector of a second sensor adjacent the first sensor and wherein each of the pairs of reflectors reflect light of a common wavelength; **(Claims 70-71)** sensors detecting acoustic disturbances in the fluid that travel at the speed of sound in the fluid, or disturbances that travel at the speed of the fluid.

14. '197 does further teach the improvement to the prior art arrangement of Figure 1 to include the arrangement of Figure 4, which comprises a serially-connected plurality of sensors each bound by a pair of first and second reflectors, wherein each sensor comprises its own

unique pair of first and second reflectors, wherein each pair of reflectors reflects light of a wavelength different from other pairs of reflectors, wherein each pair of first and second reflectors is not unique to a sensor such that the first reflector of a first sensor comprises the second reflector of a second sensor adjacent the first sensor and wherein each of the pairs of reflectors reflect light of a common wavelength in order to decrease cross-talk between sensor pairs in an array of sensors.

15. Kersey '130 teaches a pulsed sensor system and an interferometric device with a path length difference positioned after a light source and before a sensor system as interchangeable with, and therefor teaches this as equivalent to, a system wherein an interferometer is used after light is passes through a sensor system (Column 8). The interferometer is used in order to enhance the phase stability of the system and therefor the resolution with respect to changes in the measurand field (Column7). The interferometer of '130 impresses a modulation carrier onto the light in the path opposite the delayed path in order to provide a high signal to noise ratio and wide dynamic range (Column 5, lines 41-55). '130 also uses an optical receiver (item 180) after an optical splitter (item 205) in order to electronically process the interferometric signal created. Also taught is the importance of selecting the appropriate duration of a light pulse, time period, grating wavelength and pulse interval (Column 3, 9 and others). Kersey '130 teaches that a routineer in the art should know how to select the above items, since the values determine whether or not the system will work. Also within a routineer's skills should be the ability to determine how to arrange sensors in a sensing system to capture desired acoustic or pressure variation signal information by spacing the sensors a known or determinable distance apart,

understood to include equidistantly. '130 also teaches the use of his system in a plurality of environments, including pressure and acoustical systems (Column 2, lines 42-49).

16. Applicant (AAA) also admits that it is known in the art to use a sensor coupled to a pipe to sense parameters within the pipe (page 10).

17. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to utilize the features and teachings of '130 and AAA in '197 in order to have several benefits. A first benefit would be to use a known expedient to enhance the phase stability of the system and therefor the resolution with respect to changes in the measurand field by placing an interferometer with a path length difference before a sensor ('130, Column7). The system would benefit by splitting the light pulses into first and second light pulses, delaying one pulse in relation to the other and then directing the split pulses through a fiber optic sensor in order to create first and second reflected signals for the first pulse and first and second reflected signals for the second pulse and then determining a phase shift between the reflected first light pulse and second grating and the reflected second light pulse and first grating. A second benefit would be to have a high signal to noise ratio and wide dynamic range by impressing a modulation carrier on the signal (Column 5, lines 41-55). A third benefit would be to process the interferometric signal created by using a photo receiver and instrumentation to detect phase changes in the signal and therefor detecting pressure and acoustical signals. Official notice is taken that the use of optical circulators, integrated optics and distributed feedback lasers (gateable distributed feedback lasers) and delay coils for time delay devices are well known in the art. See In re Malcolm, 1942 C.D. 589; 543 O.G. 440, and the prior office action teaching these expedients. Regarding the use of an optical amplifier, optical amplifiers are well known in

the art for increasing the output signal and the signal to noise ratio. In a sensor system, an amplifier would aid in the assurance that the input signal would reach the output of the system. Official notice is taken that the use of optical amplifiers is well known in the art for the reasons given above. See In re Malcolm, 1942 C.D. 589; 543 O.G. 440. Kersey '130 teaches that it should be obvious to a skilled artisan to select the appropriate duration of a light pulse, time period, grating wavelength and pulse interval (Column 3, 9 and others), since the values determine whether or not the system will work. Kersey '197 teaches it would obvious to one of ordinary skill in the art at the time the invention was made to arrange the reflectors within a sensor system serially and spaced as outlined above for the purpose of reducing cross-talk between sensor pairs in an array of sensors. Applicant admits that it is obvious to couple fiber optic sensor systems to pipes to sense disturbances in the pipe by wrapping the sensor around the pipe. It would be further obvious, in light of '130, to use a sensor system as outlined above to sense pressure and acoustical disturbances and to extrapolate relevant information about those disturbances regardless of the speed of the disturbances, since the sensor systems are designed to achieve that goal. Also, it has been held that a recitation with respect to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus/method from a prior art apparatus/method satisfying the claimed structural limitations. Ex parte Masham, 2 USPQ2d 1647 (1987).

Response to Arguments

18. Applicant's arguments with respect to claims 1-31 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

19. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Patent to Varnham (US 6,195,162) teaches the use of directional couples to include splitters and circulators, the use of an optical amplifier to improve signal to noise ratios and to increase the optical signal in the system, and the use of integrated optics. Application to Varnham (US 2001/0013934) does not teach pulsing of optical signals, but does teach the use of a splitting device to create first and second light signals that are incident on first and second gratings of a sensor pair in a sensor array. The application teaches the reflection of the signals and the coincidence of only two of the four reflected signals created, the coincidence is due to the selection of appropriate path length delay and sensor length to include the length of the delay being equal to the double-pass time of flight of the sensor. Sensor pairs have gratings of matching wavelengths, and serial sensors in the array are unique by having gratings of different wavelengths so that sensor pairs do not overlap in their use of the gratings. Patent to Farhadiroushan (US 5,754,293) also teaches the use of a time delay equal to the double-pass time of a sensor.

20. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, THIS ACTION IS MADE FINAL. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

21. A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period

will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

22. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Krystyna Suchecki whose telephone number is (703) 305-5424. The examiner can normally be reached on M-F 8-6, with alternating Fridays off.

23. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Robert Kim can be reached on (703) 305-3492. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9318 for regular communications and (703) 872-9319 for After Final communications.

24. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 305-4900.

ks
April 21, 2003